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BIM Performance Improvement Framework for Syrian AEC Companies

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Abstract:

The Architectural, engineering, and construction (AEC) industry projects in Syria struggled with myriad problems. However, Building Information Modelling (BIM) technology worldwide proves its capability to solve these issues, Syrian AEC companies are rarely using BIM. Therefore, the aim of this study is to improve the BIM performance in Syrian AEC companies which are already in the BIM zero level and to provide strategies to the companies which do not use BIM for BIM adoption in their projects. An extensive literature review has been conducted to investigate the latest strategies and frameworks to implement and improve BIM performance. In addition to, an online questionnaire analysed by SPSS software and Excel to develop the suggested framework. Furthermore, the General Company for Engineering Studies and Consultations (GCEC) is selected as a case study to validate the framework. This study assessed and enabled the company to improve its BIM performance by using BIM maturity matrix (BIM3) through three stages: 1) Identified BIM and its performance, 2) Performance measurement, 3) Performance improvement. This study provides a new and novel companies' BIM performance improvement framework which consisted of three fields: policy, process, and technology. The results of this study assisted to identify, obtain, and improve BIM interactions between individuals and companies to enhance the collaboration between all project participants. The future research will attempt to test and validate the proposed framework for private sector companies.

Keywords: BIM Maturity; AEC; Syria; Performance Improvement; Policy; Process; Technology

1. Introduction:

The AEC industry plays a vital role in Syria's socio-economic growth (Ahmed, S., et al., 2014). However, the AEC industry in Syria facing myriad issues such as schedule delays, over budget, low quality, lack performance, poor productivity, and less efficiency (Ahmed, S., et al., 2014, Hassan, B., et al., 2010). In the last two decades, developed countries used BIM to mitigate, overcoming those problems, and benefit from the advantages of BIM implementation (Elhendawi, A.I. 2018).

Currently, Performance management and measurement are unused as a performance improvement tool in Syrian AEC projects, However, Performance measurement is the first and the essential step to enhance the AEC projects performance (Maya, R.A., 2016). In addition to that, BIM maturity level in Syrian AEC projects is still in level 0, which means that there isn't significant BIM implementation in Syrian AEC projects. Furthermore, there is lack of researches relevant to BIM in the AEC industry in Syria and the awareness about BIM is very low.

Therefore, this study aims to develop a BIM performance improvement framework in AEC industry companies in Syria. To achieve this aim, a methodology consisted of three stages are followed. The first stage is an extensive literature review followed by an online survey which investigates the AEC industry projects participates perspectives on the key factors influencing BIM implementation which

represent strategies for AEC industry companies to adopt BIM. Whereas, the third stage is the observation of the GCEC's behaviours, capabilities and its engineers and decision makers perspectives on BIM performance improvement as a case study.

This study provides a framework to improve the BIM performance within the Syrian companies scale. The proposed framework provides clear strategies and a better understanding of BIM and its fields (Technology, Process, and Policy) to facilitate the gradual transition of the Syrian AEC industry companies towards the BIM.

2. Literature review:

Overview:

There is no precise BIM definition every expert or researcher defined BIM as his perspectives'. Succar, B., (2010a), defined BIM as "*a set of technologies, processes, and policies enabling multiple stakeholders to collaboratively design, construct and operate a facility in virtual space*". However, Autodesk, (2018), argued that "*BIM is an intelligent 3D model-based process that gives architecture, engineering, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct and manage buildings and infrastructure"*. In spite of that, the different definitions emphasis that BIM help all AEC projects participants to collaborate in an intelligent environment to improve the projects efficiency, performance, and achieving the stockholder requirements.

Succar, (2010a) claimed the BIM field as: technology, process, and policy. BIM policy is the field of interaction generating the best practices for the purpose of saving benefits and minimizing conflict between BIM stakeholders. The BIM Process is the field of interaction generating and maintaining building information models. The BIM Technology is the field of interaction to generate and maintain building information models. See "Figure 1".

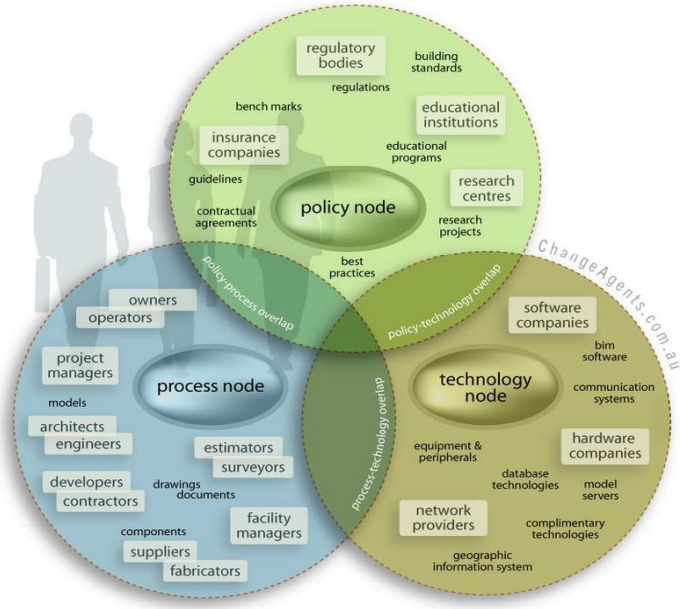

Figure 1: The interlocking fields of BIM activity(Succar, B., 2010)

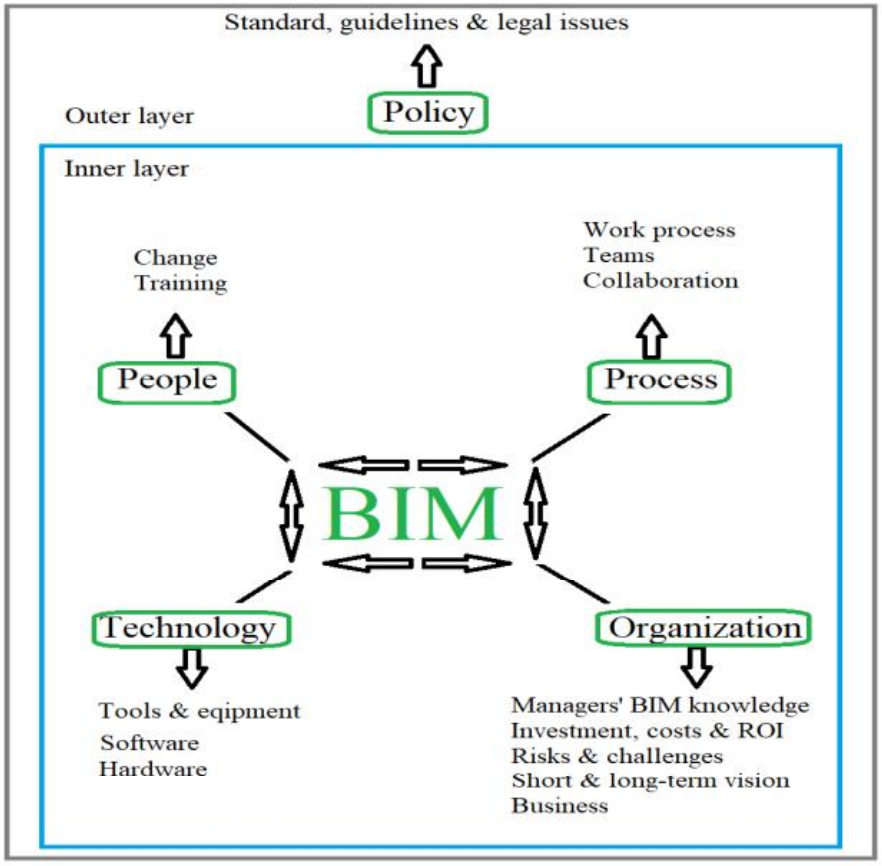

Figure 2: The key factors and BIM fields (Koucha, A.M. et al 2018)

On the other hand, Succar, B., (2010a) defined the BIM Performance as the ability to deliver BIM-enabled outcomes:

- Unique outcomes: clash detection, code checking, and constructability of complex geometries.
- Improved outcomes: coordinated drawings, improved prefabrication, more accurate costs.
- Increase productivity: better design, better quality, and better service. And reduce waste: less rework, less physical waste, less conflict, waste of time.
- It is the ability to improve certainty: cost certainty, time certainty.
- Enable fast-tracking: construction sequencing, collaborative workflows.
- Reduce environmental impact: thermal analysis, carbon footprint.

Therefore, to improve the companies' BIM performance, all the BIM outcomes must be gained with high quality, certainty, and efficiency.

Whereas, McPartland, R. (2018) argued that the BIM outcomes different according to the BIM level. the AEC industry witness myriad evolution in its developing journey starting with the hand sketch and the computer aid design (CAD) into the digital age. The BIM levels terminology refers to the level of maturity within implementing BIM in the country or in AEC Company which has the range from 0 to 4. McPartland, R. (2018) claimed that there are four BIM maturity levels as follows:

- Level 0 BIM: referred to no collaboration, 2D CAD drafting, and use paper or electronic prints. The majority of the AEC industry is in this level (NBS, 2017).

- Level 1 BIM: 3D CAD or Modelling 3D. Common Data Environment (CDE) such as electronic document management system (EDMS) should be implemented, to allow the exchange of the information between all the project players.

  To achieve Level 1 BIM, It should be achieved the following: 1) Roles and responsibilities should be agreed upon, 2) Naming conventions should be adopted, 3) maintain the project-specific codes and project spatial coordination.

- Level 2 BIM: featured by collaborative environments, and demand an information interchange process and harmonious between various systems and project stockholders.

- Level 3 BIM: UK Government provides a Level 3 Strategic Plan which identified key features for this level as follows: 1) international 'Open Data' standards, 2) A new contractual framework, 3) a unified cultural environment seeks to learn and share, 4) Training the public sector clients, 5) Driving local and global growth and jobs in BIM.

Mark Bew and Mervyn Richards, in 2008, developed a BIM Maturity Diagram as shown in figure 3 (Sinclair, S., 2012). *The* diagram acknowledges the impact of both data and process management on BIM and defines various levels of maturity for BIM (Sinclair, S., 2012).

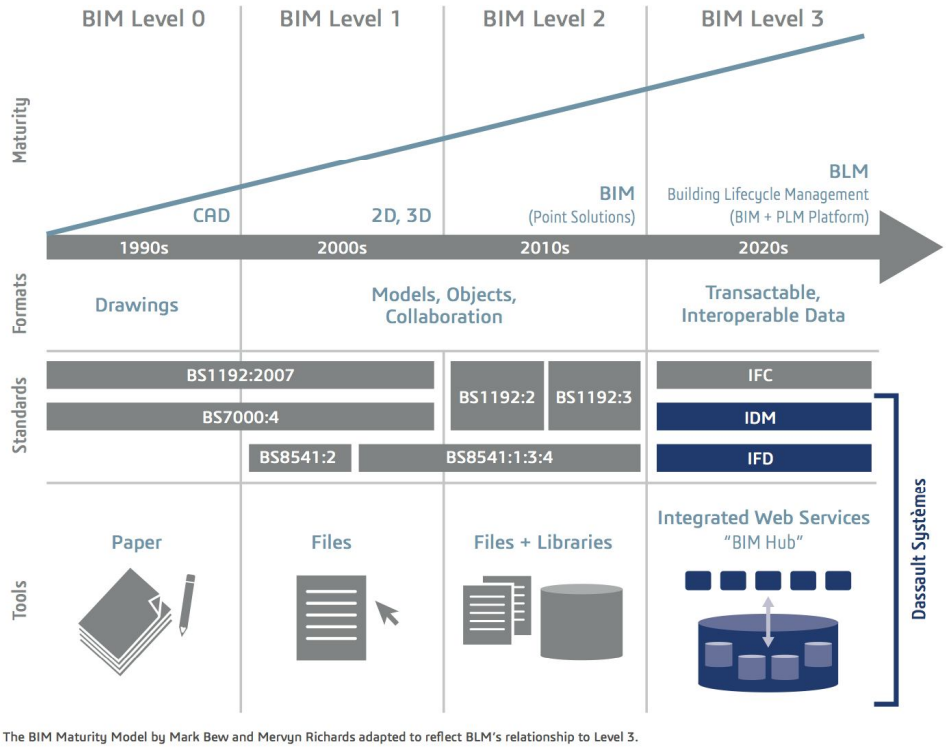

Figure 3: BIM Maturity Levels by Bew –Richards (BIMIWG, 2011)

However, the current BIM knowledge level of Syrian construction companies and engineering is very low, it expected that the full adoption of BIM in Syria will be within the next five years [2].

Ahmed, S., et al. 2018 claimed that BIM is most appropriate to the design stage, and it can be used in the construction stage. However, several researchers claimed that BIM is suitable for all the project stages (Omar, H.S., 2015, Elhendawi, A.I., 2018). Whereas Ahmed, S., et al. 2018 claimed that BIM can solve 50-75 % of the current AEC industry projects problems, Omar, H.S., 2015 added that BIM enhances the industry performance and efficiency.

On the other hand, Omar, H.S., 2015 claimed that the key barriers that impeded BIM implementation are: 1) lack of Management adhering to applying BIM, 2) the resistance to change, and hang on to the old methods of working. However, Ahmed, S., et al. 2018 categorized the barriers and challenges that hinder the application of BIM into economic, technical, organizational, legal, human challenges, and the risks associated with using a new technology.

However, Ahmed, S., et al. 2018 claimed that the main factors influencing the BIM adaption in Syria are: 1) including BIM in university curricula provide a new BIM expert generation of Syrian engineering, 2) Syria government support is the main engine for the BIM adoptions, 3) The designers play a vital role to adopt and convince others project parties about the benefits of BIM throughout the projects life cycle, 4) Prepare a time plan to training the BIM unqualified staff, 5) provide standard to deal with the principles and techniques of BIM. Omar, H.S., 2015 and Elhendawi, A., (2018) summarized these factors as: 1) Raising the awareness of BIM to motivate all the AEC players to mandate BIM, 2) The government can play a vital role to introduce appropriate execution plans to implement BIM stipulating a timeframe to mandate BIM as a compulsory requirement in the AEC industry, 3) Including BIM in the AEC undergraduate and postgraduates' syllabuses to present to the AEC industry a new BIM experts generation, 4) Surrounding environment and competitive pressure, 5) Flexibility to change.

Moreover, the absence of guidance for organizations looks forward to adopting BIM hinder the organizations to implement BIM. Successful implementation of BIM requires identifying the current status of the organizations in several aspects, such as the qualifications, capabilities, and willingness of staff to move to this new system (Amaratunga, D. and Baldry, D., 2002). In addition to the desire of the administration to adopt and its readiness to set a special budget to improve the reality of the organization to soft transfer to better levels that help in adopting BIM technology and benefit from it.

BIM Evaluation and assessment:

Maya, R.A., (2016), recommended that the Syrian companies have to use project management techniques and IT, increase training activities and use advanced tools to enhance the construction projects performance. Several researchers defined BIM as project management techniques (Omar, H.S., 2015, Succar, B., 2010b) and other argued that BIM as a project management tool (Autodesk, 2018). Therefore, BIM is suitable to improve AEC projects performance.

Several researchers developed BIM assessment frameworks as follows:

I-CMM BIM assessment framework:

As the earliest and most used assessment framework in the US, the National Institute of Building Science proposed the BIM Interactive Capability Maturity Model (I-CMM) based on 11 criteria (data richness and information accuracy etc.) with 10 capability maturity levels for each. It intends for

'users to evaluate their business practices along with a continuum or spectrum of desired technical level functionality' as well as 'for use in measuring the degree to which a building information model implements a mature BIM Standard'. Regarding its single aspect of assessment in information management, it is not for any benchmarking purpose or for 'BIM implementations comparison' (Kam, C., et al., 2013).

BIM proficiency Matrix (BPM):

In order to evaluate the individual's BIM skill proficiency, for both designers and contractors Kam et al., 2013) developed a BIM proficiency Matrix (BPM) with eight categories and each category has been divided into four maturity levels. A score is also presented with associated certifications. From the present author's view, there is not enough information available for research purposes or validation processes to test its validity. Kam believes this assessment method lacks social aspect consideration.

BIM3 – Succar BIM assessment framework:

Succar, B., 2010a developed a BIM Maturity Matrix (BIM³) as 'a knowledge tool which incorporates many BIM Framework components for the purpose of performance measurement and improvement'. Measurement provides the basis for a company to assess how well it is progressing towards its planned aims, help to identify areas of strengths and weaknesses and decides on future recommendations. The BIM³ has two axes - BIM Capability Sets and the BIM Maturity Index [20]. BIM Capability refers to the minimum abilities of an organization or team to deliver measurable outcomes. BIM Maturity refers to the gradual and continual improvement in quality, repeatability, and predictability within available BIM Capability BIm3 contains five components (Succar, B., 2010b) as BIM capability Stages representing transformational milestones along the implementation continuum.

1. BIM maturity levels representing the quality, predictability, and variability within BIM Stages.
2. BIM competencies representing incremental progressions towards and improvements within BIM Stages.
3. Organizational scales representing the diversity of markets, disciplines and company sizes
4. Granularity levels enabling highly-targeted yet flexible performance analyses ranging from informal self-assessment to high-detail, formal organizational audits.

BIM Characterisation Framework (Gao, (2011)):

Gao, (2011) proposed a characterisation framework for BIM, with the intention to understand how BIM should be conducted and who should be involved. This framework has divided BIM-based project information into 3 categories, 14 factors and 74 measures.

Organisational BIM assessment framework (Kreider, (2011)):

A BIM maturity framework from client/facility owner's perspective was developed by Kreider (2011) for organisational BIM (OBIM) usage. This assessment framework contains six main areas: strategy, uses, process, information, infrastructure and personnel's BIM competency.

This study selects BIM3 – Succar BIM assessment framework due to being simplified and appropriate to the selected company scale and capabilities.

Strategies and frameworks for BIM implementation:

Several researchers developed many Strategies and frameworks for BIM implementation such as the following:

BIM framework for practical implementation (Jung, Y. and Joo, M., 2011):

Jung, Y. and Joo, M., (2011), developed a framework with six major variables classified into three dimensions in a hierarchical structure. The three dimensions include 'BIM technology', 'BIM perspective', and 'construction business functions' as illustrated in Figure 4.

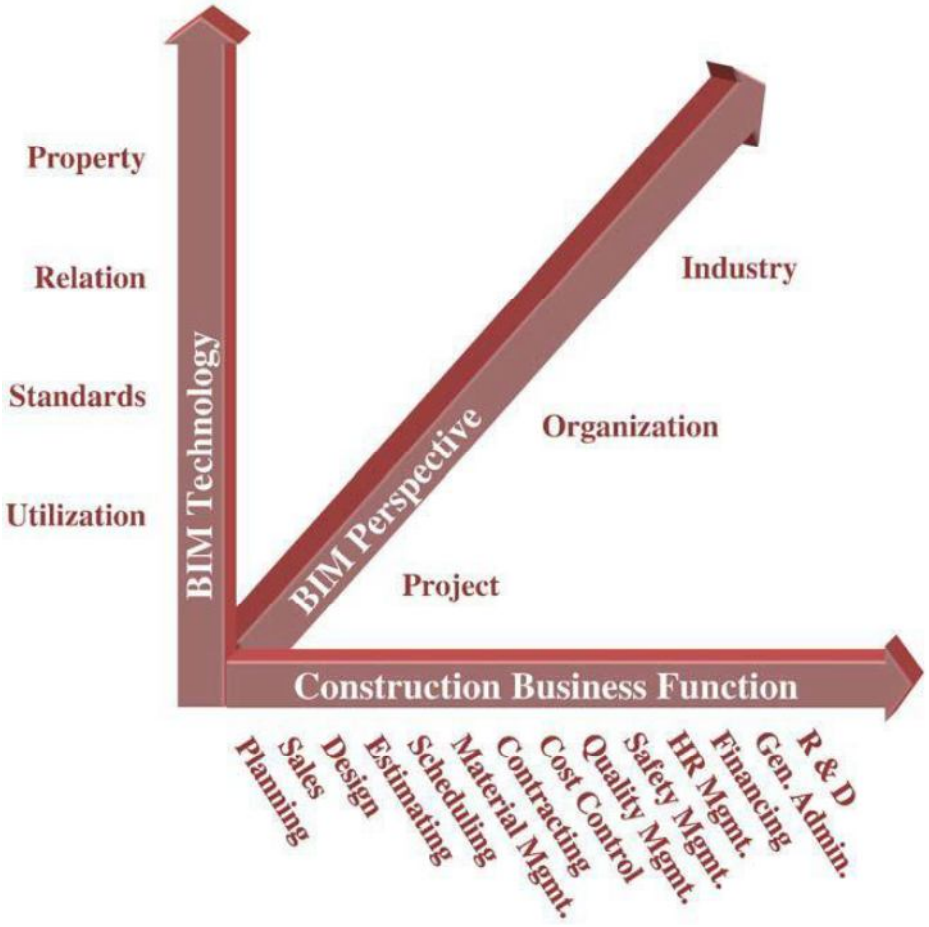

Figure 4: BIM framework for practical implementation (Jung, Y. and Joo, M., 2011) [10]

Jung, Y. and Joo, M., (2011)'s framework can be used as evaluation criteria for BIM's practical Implementation within different BIM perspective (Project, Organization, and Industry). This study trying to find framework more appropriate to organization scale.

In spite of, Koucha, A.M. et al, (2018) suggested a framework to implement BIM which consisted of three steps namely: understanding, Planning, and piloting. As shown in figure (5).

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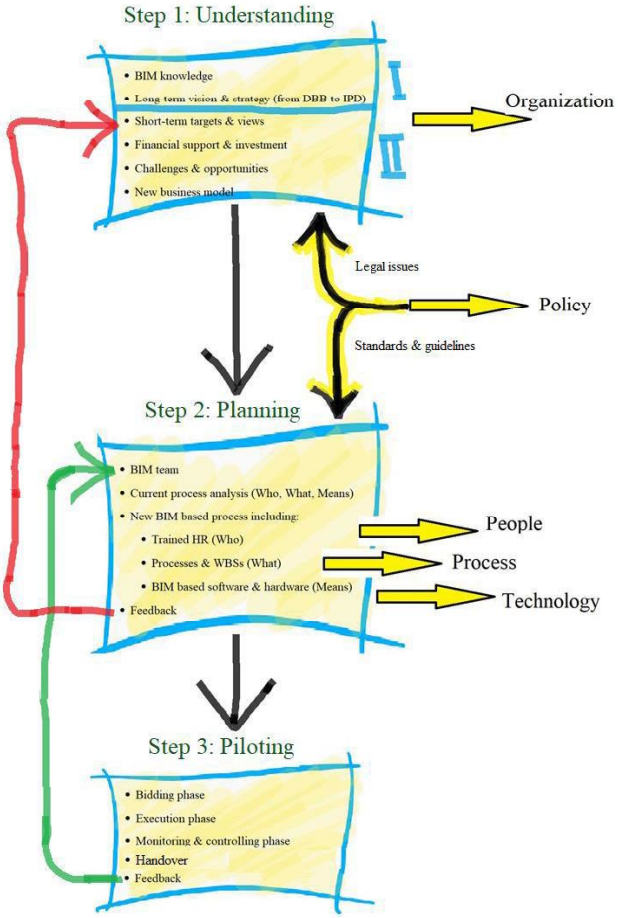

Figure 5: BIM implementation framework (Koucha, A.M. et al 2018)

Koucha, A.M. et al, (2018) framework is limited to an initial BIM implementation framework for small and medium contractors companies. Therefore, there is a need for a framework deals with different types of companies including the scale of the large company.

There are a few types of research related to BIM in the AEC industry in Syria. Thence, there is a knowledge gap about a framework or a strategy to implement BIM. This research tries to fill this gap to provide a framework to BIM performance improvement in AEC industry Syrian companies.

3. Research Methodology:

The methodology includes three stages: reviewing the literature, conducting a questionnaire, and observation a case study, as shown in Figure 6. **The first stage:** an extensive investigation for the literature review to build a deep understanding to cover the stipulated research scope. **The second stage** is collecting and analyzing the data from an online questionnaire to develop the proposed Framework.

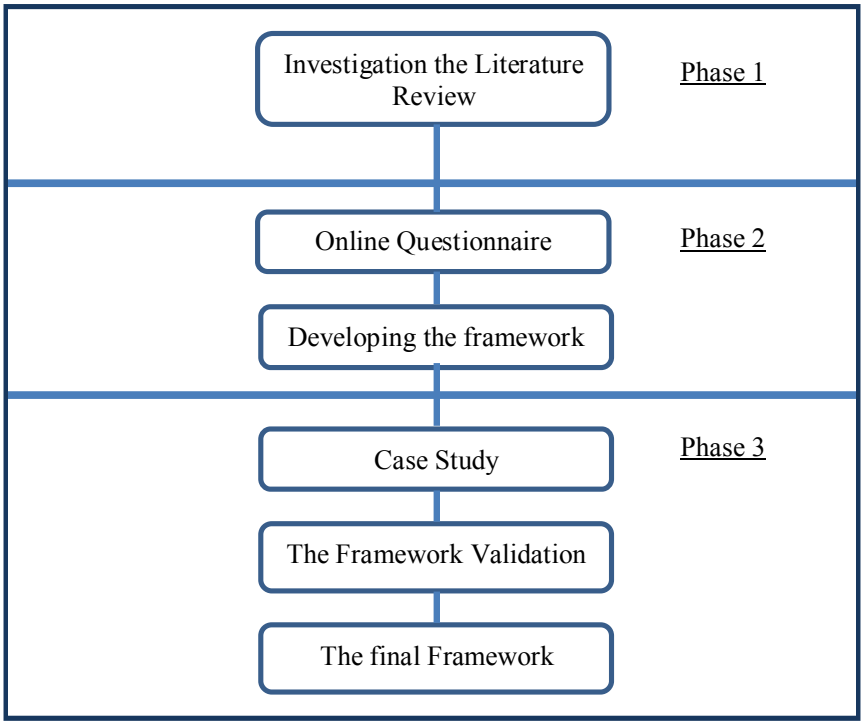

Figure 6: Research Methodology

The questionnaire consisted of 34 questions, 89 corrected received responses from respondents. It represents a segment of the Syrian engineers in several governorates which reflects Syrian position in the current circumstances. The result emphasized that 50% of the respondents aware of BIM and 23.8 % have worked on at least two projects related to Modelling. This means the tendency towards the philosophy of building information modeling for the new generation of Syrian engineering, indicating the potential evolutionary power of this philosophy over the next few years.

The respondents hold a varying degree from Bachelor to Diploma, Master and Ph.D. in Engineering in most of its specializations which represent the whole Syrian AEC projects participants. The most of them are civil engineering (60%), followed by architectural (25.8%), mechanical, electrical and others. The majority of respondents were designers, project managers, consultants and other working groups in several different companies: studies, Execution, Syrian Universities, and Engineers Syndicates located in several governorates. In addition to, some private engineering offices, buildings belonging to the Ministry of Health, Culture, Tourism, Ministry of Public Works, Ministry of Housing and others.

The majority (80 %) of the respondents exceeded 15 years of experience and 20% of them are still in the range of 2 to 5 years. the most of the respondents (30%) work in the field of residential construction and 26% work in the education sector, represented by the Syrian universities spread throughout the Syrian territory.

The conducting survey covers BIM adoption between Syrian engineers and both public and private building sector; the result represented that 57% of responders consider their selves as BIM users

(Figure 7), but in fact, they know a little about BIM. In spite of this, 44% think that Syria can be adopted BIM during the next five years. With emphasizing to the government role in the compulsory mandate of BIM. Revit is the most famous BIM tool among Syrian engineers; about 61% of the respondents believe that BIM can be useful in the design stage while 21% indicated that they can implement BIM in both design and construction stage of the project. Unfortunately, due to the lack of the budget allocated for the training and rehabilitation of employees, or fear of the high cost of adopting this technology and the use of programs. 31% of staff rely on self-training, and only 24% of them receive formal training in addition to their effort.

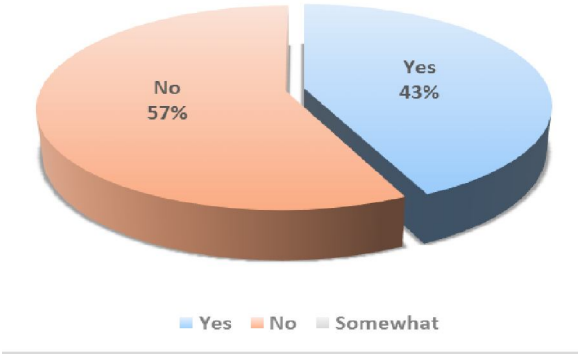

Figure 7: Percentage of BIM users

The third stage: General Company for Engineering Studies and Consultations (GCEC) has chosen as **a case study** to measure its reality and readiness to begin a gradual plan towards adopting BIM. The reason for choosing is: GCEC is the largest and most important company in Syria in the designing field. The GCEC is committed to quality, excellence and continuous development in its performance and a high level of creativity and innovation, and the application of commercial quality standards through a team of integrated technical engineers and administrators with a brilliant experience. The company's staff consists of 2190 employees working in locations spread throughout Syria. The director of GCEC- Branch of Coastal Zone is interested in keeping pace with the scientific developments, and the introduction of modern technology. The company team used the BIM tool Revit from 2006 which gave them an idea about the new technology, and the high benefits that a company can gain by adopting BIM. This study dealt with the Coastal Zone Branch as a first step towards pushing other institutions to go for competition.

There are three measurement scales according to BIM performance measurement overview established by (Ahmed, S., et al., 2014): Individual, Organizations, and Markets. This study used the *Organizational Capability & Maturity* scale by developing a strategy by using BIM Maturity Matrix "BIM3". By using it, this study provides some recommendations in three BIM fields: Technology, Process, and Policies. The BIM3 is intended for low-detail organizational self-assessment. For best results, must follow the below-recommended steps:

- Identify the best person to lead the assessment effort – someone with significant experience in BIM tools, workflows and protocols and sufficient insight into the organization' systems.
- Manner this assessment as a group activity, a workshop with 3-9 individuals representing punishments and seniority levels.
- Set aside one hour to complete the self-assessment exercise and its follow-up discussions.

The matrix has translated into the Arabic language and presented to a group of experienced engineers in the company (GCEC); a meeting held between them and the researchers, to explain the matrix and

its working structure. The engineers were asked to apply the precise method of processing and answering accurately for each cell after reading all the cells of each group, and to put a signal to clarify the cases achieved in the company after reading the entire line of each capability. The numbers placed under each cell are intended to determine exactly where the problem is and to discuss solutions, not to give an indicative number and computational ratio.

As a result of the above three stages, the study enhances the Performance improvement and providing recommendations according to the performance measurement mention above.

4. Results:

Questionnaire (Developing the proposed Framework):

The respondents (49%) claimed that BIM has the ability to solve 50-75% of the current building problems. This result is as similar to what Elhendawi, A., (2018) said. In addition to that, 37% of the respondents believe that BIM should be compulsory under the guidance of the government, which is considered to be the main engine for the adoption of the BIM. As the same as Omer, H., (2015) s' result.

Furthermore, as illustrated in figure 8 the most source for BIM experience gained from the university stage. Whereas more than 22% believe that the designer is the main engine to adopt and convince others about the benefits of BIM as part of construction projects in Syria. This is also found in global research where there is a possibility to solve more building problems, avoid redesign and reduce change orders, which are the main factors that lead to the failure of projects to reach their goals within the cost and time set since the beginning of work (Omer, H., 2015, Elhendawi, A., 2018).

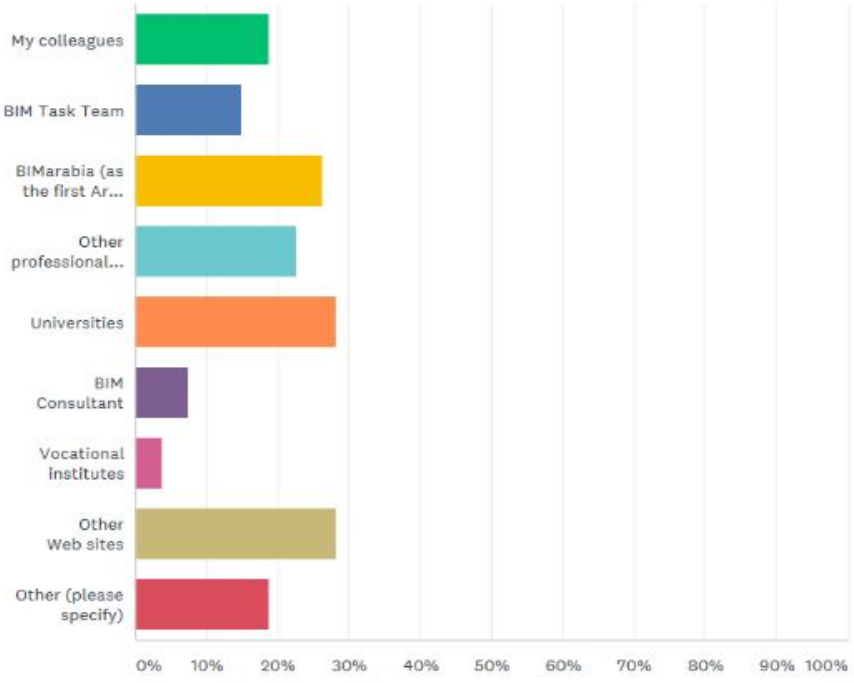

Figure 8: the most commonly used sources of experience in the field of BIM

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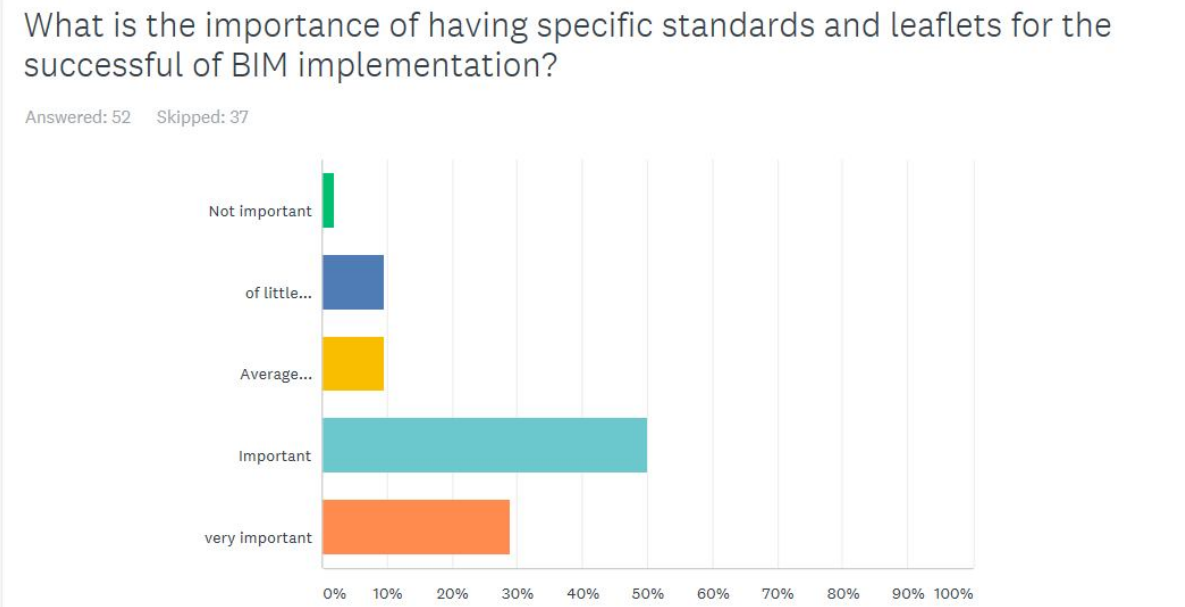
The majority of respondents 50% argued that setting a special standard to deal with the principles and techniques of BIM is important, While 29% find it is very important as shown in figure 9. This result is in line with what Omer, H., (2015) claimed.


What is the importance of having specific standards and leaflets for the successful of BIM implementation?
Answered: 52 Skipped: 37
Not important
of little...
Average...
Important
very important
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

ANSWER CHOICES	RESPONSES	
Not important	1.92%	1
of little importance	9.62%	5
Average importance	9.62%	5
Important	50.00%	26
very important	28.85%	15
TOTAL		52

Figure 9: important of existing standards for the use of building information Modelling (BIM)

The respondents mentioned the most important risks that may face the projects that will be implemented using the BIM as follows (figure 10):

- Risks of lack of clarity (unclear specifications, customer requirements, required quality of achievements).
- Misappropriation of information and consequential errors in construction works.
- The 3D models and their 2D exports have not been updated due to lack of cooperation between the parties to the project.

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ANSWER CHOICES	RESPONSES	
Risk of lack of clarity (unclear specifications, customer requirements, required quality of performance).	45.28%	24
There is no evidence to support supply chain experiences in the BIM project and the suitability of these expertise with project requirements.	28.30%	15
Not to update the 3D models and their 2D exports due to lack of cooperation between the parties of the project.	37.74%	20
Wrong transmission of the information and consequently errors of construction work on the site.	39.62%	21
Accidents and inaccuracies of technology (software, scanners, cloud points ...)	20.75%	11
Risk of non-compliance with contract terms such as payments, quality, and time.	30.19%	16
inaccuracy in information provided by gifts and tenders such as estimating quantities and costs.	20.75%	11
Delay in schedules.	13.21%	7
Total Respondents: 53		

Figure 10: Main risks facing projects implemented using BIM

This result is in line with what Elhendawi, A., (2018) concluded.

The respondents mentioned the most important factors influencing the localization of BIM as illustrates in Figure (11) as follows:

- Raising the awareness of the importance of cooperation culture between different parties
- Government policy to make the use of BIM technology mandatory through the development of special laws
- Establish an educational base for BIM technology by making it part of the curricula of universities
- Providing government support for the implementation of BIM technology in private companies and institutions
- Allocate financial funding to support the costs of BIM technology
- Engaging with international specialists with expertise in BIM technology
- Development of contracts and legal materials governing the use of BIM technology.

This result is in line with what Elhendawi, A., (2018) and Omer, H., (2015) claimed.

The proposed Framework (Figure 12) was developed dependent on the extensive literature review, and the recognized three fields of BIM and the results from the questionnaire survey analysis.

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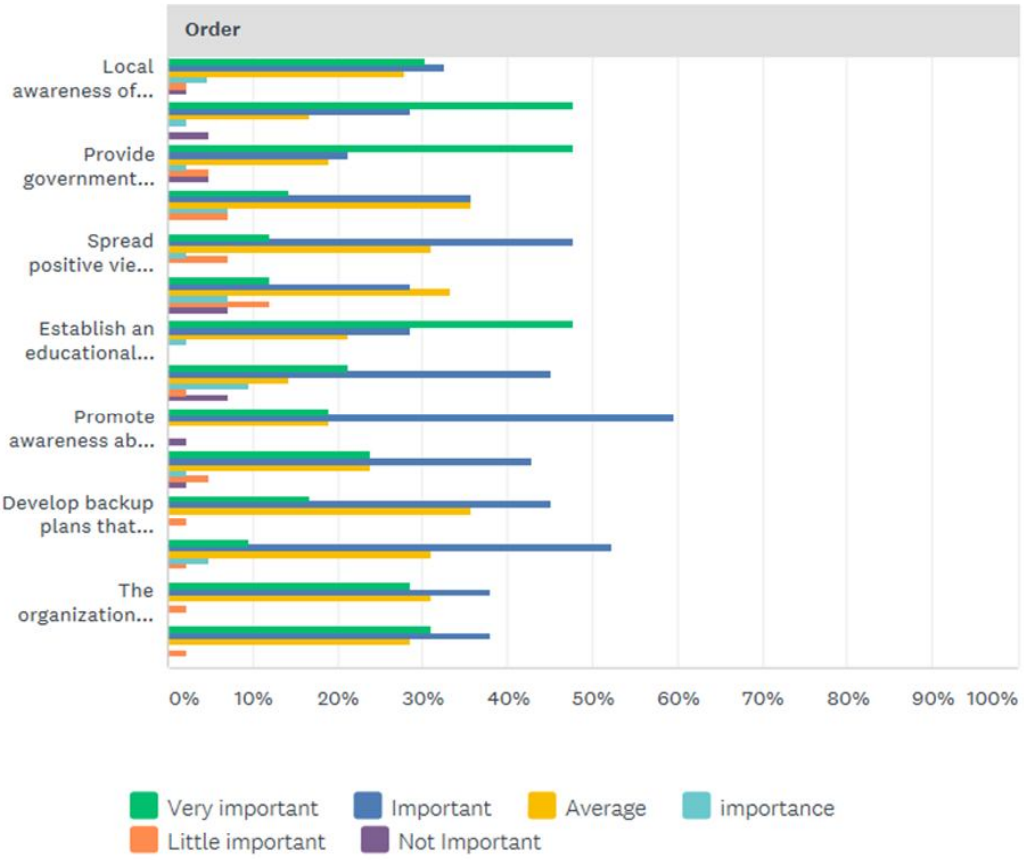

Figure 11: the most important factors help in the localization of BIM in Syrian construction projects.

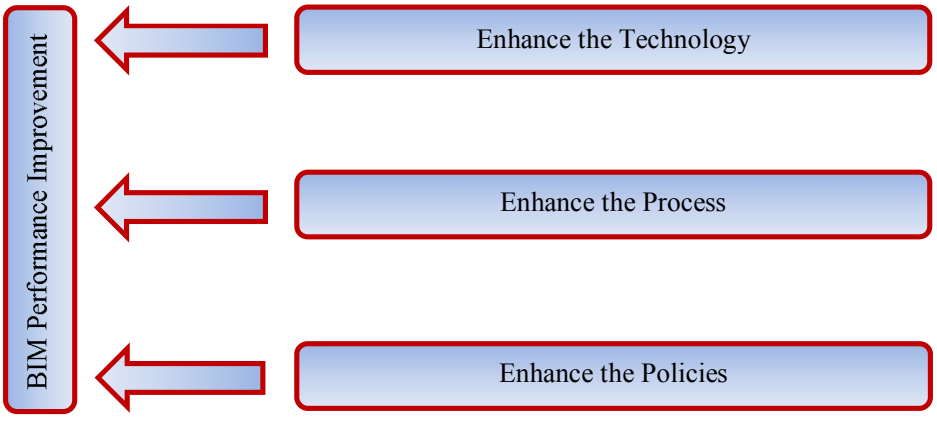

Figure 12: the proposed Framework.

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Case study (Framework Validation):

BIM Performance Measurement in the GCEC Company

The validation of the proposed framework is conducted by observing the BIM performance measurement in the GCEC Company through the fields of BIM.

Technology

- *Software*: *(applications, deliveries, and data):* Company has achieved column b (specific) in addition to attaining one aspect of cell c; the final value is 11 out of 40. In this case, with cells with lower values, these cells have a priority in working to improve them. All cells must have this optimization. Therefore, to move the software in the company to the column (the subsequent cell) (orbit) entirely and also towards the integration and optimization as much as possible, for example:
  - Setting strategic goals for the company and based on which programs are selected and managed
  - Enable interoperability of various applications by proposing formats such as IFC, which helps to use, store, share and maintain data as part of the overall strategy of the company.
- *Devices*: *(equipment, delivery, location/roaming):* The assessment has the result 0. Therefore the hardware is not suitable for the process of BIM, so:
  - Buying appropriate equipment for Building Information Modelling, and purchase workstation equipment that can be cheap or used but with good specifications (gradual change).
  - Convince the management that the replacement and promotion of equipment is an investment.
  - Standardization of hardware specifications within at least one team.
- *Network: (Solutions, Delivery, and Security/Access Control):* its assessment value was 0; which means that the network mode is not useful, you must look for the reasons.
  - It must secure the network and its solutions to ensure that information is shared between teams within a single organization and between organizations working together.
  - Solutions can replace with innovations that are regularly tested and evaluated, such as: Ensuring proper bandwidths that allow storage and exchange of data and knowledge
  - The allocation of project portals that allow for the exchange of significant data and make it interchangeable between the stakeholders in the project, leading to the participation of different parties and this reflected in improving the process and development of communication channels.

Process

- *Resources (infrastructure, physical and precognition):* The assessment has the value of 5, the Company's employees consider that the work environment and workplace tools directly affect employee motivation and productivity. So:
  - Control this environment and secure the appropriate work tools and work on the management and integration, which achieves the company's performance strategies.
  - Monitor the work environment regularly to suit the requirements of its employees and contribute to their ability to more work and productivity.

- There is also poverty in the way of exchange and sharing of knowledge. Also recommended using specific standards and shared data environment (like CDM) and commitment which will stimulate employees and increase productivity.

- *Activities and Workflow (Knowledge, experiences and related dynamism):* The value is 10 out of 40 as illustrated above. There is good knowledge of an essential section of the company's members about BIM and its benefits and the need to apply it. So that:
  - A BIM team should be formed, the roles of all participants should be defined, and the technology should be introduced into a small pilot project and then they become essential in the company work.
  - Create a spirit of cooperation and provide the necessary communication tools within the working group and within the organization in general.
  - Gradually replace the traditional teams with newly trained teams. Or training the existing teams gradually so that the transition doesn't cause any defect or delay in the work of the company.

- *Products and services: (specification, differentiation, research, and development):* Based on the answers of the company engineers, it took value 10.
  - The company recognizes that it uses a unique statement to define the specifications and characteristics of the components of the 3D model, but there is no individual standard (such as an integrated BIM model which serves as a reference model for mensuration) can be consulted indicating the specifications to be achieved if the model is submitted.
  - To reach a product with high specifications; must specify the specifications for the progress of the model and control the product in the desired stages of development.
  - Adopt a national or international code.

- *Leadership and management: (organizational, strategic, managerial, communication, invention, and innovation)*: The rating is 0,
  - The first important step is to persuade the management to move to the BIM and provide all the supporting factors.
  - Cooperate with the supplier and develop a method to deal with him.

Policies

- *Preparation: Research, educational/training, and delivery programs*. It came in a specific box and took the assessment 10 out of 40
  - Training should be adopted on an ongoing basis and not when necessary
  - Set specific strategic objectives, so that the training fructifies.
  - MEP needs special attention. If the architectural and structural specialist had followed the REVIT and MEP engineer followed the AutoCAD program, the company would not be working on the second level of the BIM.
  - Developing a time plan.
  - Involve all parties, even those who do not work with BIM, like Quality management, and Planning.
  - Innovation strategy.

- *Organization: Blogs, regulations, legislation, classifications, guidelines, and standards*, The rating is 0
  - This study recommends the adoption of reliable codes such as British code.
  - Evaluation for each project, is the code used for this situation?
  - Need the guidance for the best methods of learning and training.

- Regarding the course, is it better to be: some long hours taught at home or class in the company.
- The development of unique records containing reports: take advantages of the recording mistakes.
- Contractual: Responsibilities, Remunerations and Risk Allocations: Also took rating 0.
- Must be done before sitting with the client and agreeing with him on the work plan.
- Method of dealing with contracts such as CIC BIM may propose to use in work within the BIM projects.

- As a result of assessing the selected company, it seems that it is approaching the level 1 of the BIM, where the engineers use some of the BIM tools as Revit architectural, and structural. In addition to the belief of the company's employees in cooperative work, which is a basic principle of the BIM. It was agreed to form the company's 6-person BIM team initially, who undertook to train others to reach an integrated team. Growing day by day.
- The selected BIM team decided to select a medium-sized project with a long and deferred time schedule to operate as a pilot project and to record this experience, benefits, and constraints in order to gradually move the company towards the BIM.
- This move will be the first in the Syrian public sector companies, and maybe an incentive to compete with other companies.

BIM performance improvement

Performance measurement is the first step to improve and manage the performance. This study provides some recommendations for every BIM areas and internal areas as shown in “Figure 13”. These results are in the line with the literature (Jung, Y. and Joo, M., 2011, Koucha, A.M., et al., 2018).

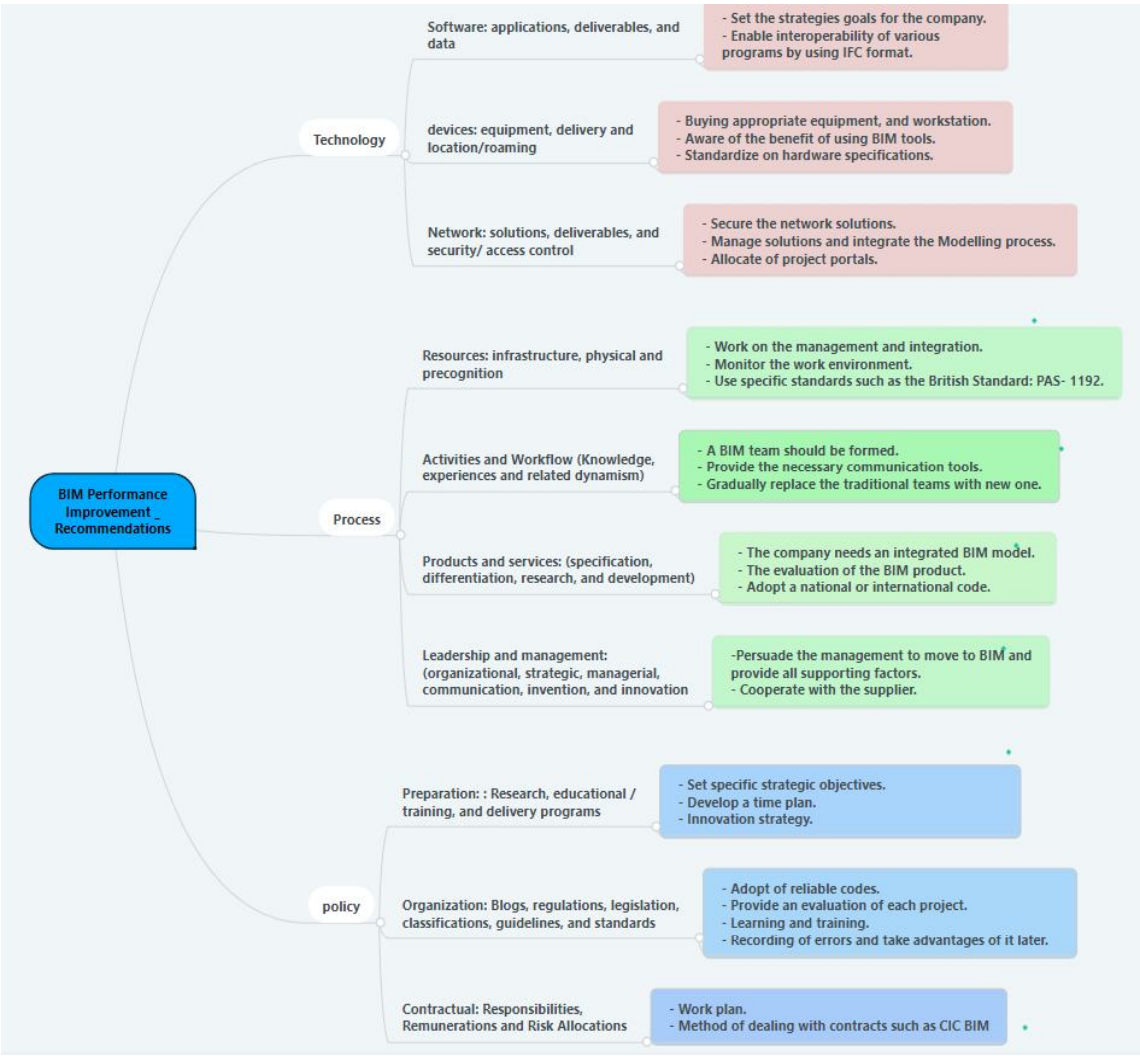
BIM Performance Improvement _ Recommendations
Technology
Software: applications, deliverables, and data
- Set the strategies goals for the company.
- Enable interoperability of various programs by using IFC format.
devices: equipment, delivery and location/roaming
- Buying appropriate equipment, and workstation.
- Aware of the benefit of using BIM tools.
- Standardize on hardware specifications.
Network: solutions, deliverables, and security/ access control
- Secure the network solutions.
- Manage solutions and integrate the Modelling process.
- Allocate of project portals.
Process
Resources: infrastructure, physical and precognition
- Work on the management and integration.
- Monitor the work environment.
- Use specific standards such as the British Standard: PAS- 1192.
Activities and Workflow (Knowledge, experiences and related dynamism)
- A BIM team should be formed.
- Provide the necessary communication tools.
- Gradually replace the traditional teams with new one.
Products and services: (specification, differentiation, research, and development)
- The company needs an integrated BIM model.
- The evaluation of the BIM product.
- Adopt a national or international code.
Leadership and management: (organizational, strategic, managerial, communication, invention, and innovation
-Persuade the management to move to BIM and provide all supporting factors.
- Cooperate with the supplier.
policy
Preparation: : Research, educational / training, and delivery programs
- Set specific strategic objectives.
- Develop a time plan.
- Innovation strategy.
Organization: Blogs, regulations, legislation, classifications, guidelines, and standards
- Adopt of reliable codes.
- Provide an evaluation of each project.
- Learning and training.
- Recording of errors and take advantages of it later.
Contractual: Responsibilities, Remunerations and Risk Allocations
- Work plan.
- Method of dealing with contracts such as CIC BIM

Figure 13: The Final Proposed Framework "BIM Performance Improvement"

5. Conclusions:

However, clients usually worried about quality improvement with reduced time, and cost, contractors, and architects are interested in performance improvements to increase their profits and enhance their competitive advantages. BIM proves its capability to enhance the cooperation between all project parties. Unfortunately, BIM is not fully applied in Syrian projects in general and within the selected company as a case study.

The majority of the public administration staff in Syria don't know quite about the BIM. This research aims to BIM performance improvement in AEC industry companies in Syria. An online survey explains the BIM adopting between Syrian engineers and determined their perspectives about the main factors influencing the BIM performance improvement. Moreover, the analysis of the company performance was based on the BIM Maturity Matrix, evaluation criteria are determined by the specific needs of the various participants of the building process. This study provides a framework to enhance

the BIM performance in the AEC industry in Syria and propose strategies for raising BIM awareness. This research provides recommendations: 1) Readiness and willingness to change are necessary to further develop the application of BIM in Syria and the world, 2) An initial team of BIM set up to be trained with the provision of subsequent staff to support the first team and start to evaluate the performance and the reality of the company and work to move gradually towards BIM as a qualitative and individual step and with remarkable cooperation for public companies in Syria.

Recommendations have been made for all aspects of the so-called BIM fields of technology, processes, and policies of the organization with an aim to improve its position and pushing it towards the second level of BIM. The influencing factors related to the technology are: 1) Setting strategic goals and selecting the appropriate programs, 2) Enable interoperability of various applications by proposing formats such as IFC, which insure using, storing, sharing and maintain data as part of the overall strategy of the company, 3) Buying appropriate equipment for Building Information Modelling, and purchase workstation equipment that can be cheap or used but with good specifications, 4) Convince the management that replacing and promotion of equipment is an investment, 5) Standardization of hardware specifications within at least one team, 6) Securing the network and its solutions to ensure that information is shared between teams within a single organization and between organizations working together, 7) Innovations would be solutions regularly tested and evaluated, such as: Ensuring proper bandwidths that allow storage and exchange of data and knowledge, 8) The allocation of project portals that allow for the exchange of significant data and make it interchangeable between the stakeholders in the project, leading to the participation of different parties and this is reflected in improving the process and development of communication channels.

The influencing factors related to the process are: 1) Controlling the BIM environment and securing the appropriate work tools and working on the management and integration, which achieve the company's performance strategies. 2) Monitoring the work environment regularly to suit the requirements of the company's employees and enhance their ability to more work and productivity, 3) Using specific standards and shared data environment (like CDM) and commitment which will encourage employees and increase productivity, 4) A BIM team should be collected, roles of all participants should be defined, and the technology should be introduced into a small pilot project and then, they become essential in the company work, 5) Creating a spirit of cooperation and providing the necessary communication tools within the working group and within the organization in general, 6) Gradual replacing of the traditional teams with newly trained teams or training the existing teams gradually so that the transition doesn't cause any defect or delay in the work of the company, 7) The company recognizes that it uses a unique statement to define the specifications and characteristics of the components of the 3D model, but there is no individual standard (such as an integrated BIM model which serves as a reference model for mensuration) can be consulted indicating the specifications to be achieved if the model is submitted, 8) Identifying the specifications for the progress of the model and controlling the product in the desired stages of development, 9) Adopting a national or international code, 10) The first important step is to persuade the management to move to the BIM and provide all the supporting factors, 11) Cooperation with the supplier and developing a method to deal with him.

The influencing factors related to the policies: 1) Training should be adopted on an ongoing basis and not when necessary, 2) Setting specific strategic objectives, so that the training fructifies, 3) Different disciplines (Architectural, Structural and MEP specialists) should use unified program, 4) Developing a time plan, 5) Involving all parties, even those who do not work with BIM, like Quality management, and Planning, 6) Innovation strategy, 7) Recommending the adoption of reliable codes such as the British code, 8) Evaluation for each project, is the code used for this situation? 9) Guidance for the

best methods of learning and training, 10) The development of unique records containing reports: take advantages of the recording mistakes, 11) Contractual, responsibilities, remunerations and risk allocations must be done before meeting the client and work plan agreement, 12) Method of dealing with contracts such as CIC BIM may propose to use in work within the BIM projects.

This study recommends selecting a medium-sized project with a long and deferred time schedule to operate as a pilot project and to record this experience, benefits, and constraints in order to gradually move the company towards the BIM.

The future researches might deal with the validation of the proposed framework in private sector companies.

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